

STORAGE DEVICE, SYSTEM INCLUDING STORAGE DEVICE AND METHOD OF OPERATING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from Korean Patent Application No. 10-2015-0108868, filed on Jul. 31, 2015, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Apparatuses and methods consistent with exemplary embodiments relate to storage devices, and methods of operating the same.

[0003] In a variety of systems, storage devices are used for storing data. Various storage devices may have different sizes, storage capacities, operating speeds, and host connection methods. An SSD (solid state drive or solid disk device) is an example of a storage device based on a nonvolatile semiconductor memory device, such as a flash memory, and has been used in a variety of applications.

SUMMARY

[0004] Aspects of exemplary embodiments provide a storage device adaptively scheduling a timing of a background operation of the storage device, a system including the storage device, and a method of operating the same.

[0005] According to an aspect of an exemplary embodiment, there is provided a method of operating a storage device in communication with a host, the method including: receiving a first target value and a second target value of a plurality of target values respectively corresponding to a first operating parameter and a second operating parameter of a plurality of operating parameters of the storage device from the host; loading a first existing value and a second existing value of a plurality of existing values of the first operating parameter and the second operating parameter; processing a machine learning algorithm using the first target value, the second target value, the first existing value and the second existing value to generate an adaptive schedule; adaptively scheduling a background operation of the storage device based on the generated adaptive schedule; and executing the background operation based on the adaptive scheduling of the background operation.

[0006] The first operating parameter may correspond to a state of the storage device, and the loading of existing values of the operating parameters may include measuring or calculating the state of the storage device.

[0007] The first operating parameter may include at least one among a number of free blocks of the storage device, a wear level index, a temperature, a rate of internal operation, and an error correction time.

[0008] The second operating parameter may correspond to a state of the host, and the loading of existing values of the operating parameters may include receiving the second operating parameter from the host.

[0009] The second operating parameter may include at least one among an input/output throughput, an input/output latency, a load index, an estimated idle time, and an estimated input/output usage.

[0010] The machine learning algorithm may be a Q-learning algorithm.

[0011] The method may further include: calculating a performance score proportional to an absolute value of the difference between the target values and the existing values using the Q-learning algorithm; and determining a timing label corresponding to a row comprising the highest Q value in a table comprised of rows of combinations of the operating parameters and columns of timing information of the background operation, and the adaptive scheduling of the background operation may be based on the determined timing label.

[0012] The storage device may include a flash memory device, and the background operation may be a garbage collection operation corresponding to the flash memory device.

[0013] The machine learning algorithm may be processed using the first target value, the second target value, the first existing value, the second existing value, a first weight of the first operating parameter and a second weight of the second operating parameter.

[0014] According to an aspect of another exemplary embodiment, there is provided a method of managing a storage device by a host in communication with the storage device, the method including: setting a first target value and a second target value of a plurality of target values respectively corresponding to a first operating parameter and a second operating parameter of a plurality of operating parameters of the storage device; loading a first existing value and a second existing value of a plurality of existing values of the first operating parameter and the second operating parameter; processing a machine learning algorithm using the first target value, the second target value, the first existing value and the second existing value to generate an adaptive schedule; adaptively scheduling a background operation of the storage device based on the generated adaptive schedule; generating a control signal to control the storage device to execute the background operation based on the adaptive scheduling of the background operation; and transmitting the control signal to the storage device.

[0015] The setting the first target value may include: receiving target performance information corresponding to an operation of the storage device; and extracting a first target value of the first operating parameter from the target performance information.

[0016] The setting of the target values for the operating parameters may include generating the first target value based on one among an operation that is being performed, an operation that is to be performed in the host, or a prescribed reference value.

[0017] The first operating parameter may correspond to a state of the storage device, and the loading of the first existing value may include receiving the first operating parameter from the storage device.

[0018] The second operating parameter may correspond to a state of the host, and the loading of the second existing value may include measuring or calculating the second operating parameter.

[0019] The machine learning algorithm may be a Q-learning algorithm, and the method may further include: calculating a performance score proportional to an absolute value of the difference between the target values and the existing values using the Q-learning algorithm; and determining a timing label corresponding to a row comprising the highest